CLAIMS

What is claimed is:

1. A method of designing underlying structures in a wafer that balances planarization and optical metrology characteristics, the method comprising:

fabricating underlying structures including one or more pads and one or more spaces, the one or more pads varying in size and/or shape;

comparing planarization characteristics of planarized layer or layers of the wafer to preset standard planarization characteristics;

fabricating target structures in the target layer of the wafer;

measuring a reflected metrology signal off a calibration test area of the target layer of the wafer to obtain a calibration metrology signal, the calibration test area having an unpatterned underlying structure; and

selecting the design of pads of the underlying structure that yields a reflected metrology signal off the target structure that is closest to the calibration metrology signal and that meet preset the standard planarization characteristics.

2. A method of fabricating underlying structures in a wafer that balances planarization and optical metrology characteristics, the method comprising:

fabricating one or more underlying structures with a predetermined design in a wafer, the predetermined design selected to meet planarization objectives and optical metrology objectives, the optical metrology objectives comprising quality of reflected metrology signal,

planarizing a surface of a layer of the wafer, the planarized surface of the layer of the wafer having planarization characteristics, and

fabricating a target periodic structure in the wafer;

wherein the planarization characteristics of the planarized surface of the layer of the wafer meet the planarization objectives and wherein quality of a reflected metrology signal off the target periodic structure meet the optical metrology objectives.

3. The method of Claim 2 wherein the planarization characteristics of the planarized surface of the wafer comprise measurements of extent of erosion and dishing of materials of the planarized layer of the wafer.

4. The method of Claim 2 wherein the one or more underlying structures include shapes and spaces, the one or more underlying structures having a loading factor, the loading factor being the ratio of area occupied by shapes to the area occupied by both the shapes and spaces.

5. The method of Claim 4 wherein the shapes include pads with geometric shapes.

6. The method of Claim 4 wherein the shapes include pads with irregular shapes.

7. The method of Claim 4 wherein the shapes include geometric shapes positioned in a random manner.

8. The method of Claim 2 wherein the one or more underlying structures in the wafer is an underlying periodic structure, the periodicity of the underlying periodic structure being positioned at an angle relative to the direction of periodicity of the target periodic structure of the wafer.

9. A method of fabricating underlying structures in a wafer that balances planarization and optical metrology characteristics, the method comprising:

fabricating one or more underlying structures with a predetermined design in a wafer, the predetermined design selected to meet planarization objectives and optical metrology objectives, the optical metrology objectives comprising quality of reflected metrology signal,

planarizing a surface of a layer of the wafer, the planarized surface of the layer of the wafer having planarization characteristics, and

fabricating a target periodic structure in the wafer;

wherein the planarization characteristics of the planarized surface of the layer of the wafer meet the planarization objectives and wherein quality of a reflected metrology signal off the target periodic structure meet the optical metrology objectives; and

wherein the one or more underlying structures in the wafer are underlying periodic structures, the periodicity of the underlying periodic structures positioned perpendicular to the direction of periodicity of the target periodic structure of the wafer.

10. A method of fabricating underlying structures in a wafer that balances planarization and optical metrology characteristics, the method comprising:

fabricating one or more underlying structures with a predetermined design in a wafer, the predetermined design selected to meet planarization objectives and optical metrology objectives, the optical metrology objectives comprising quality of reflected metrology signal,

planarizing a surface of a layer of the wafer, the planarized surface of the layer of the wafer having planarization characteristics, and

fabricating a target periodic structure in the wafer;

wherein the planarization characteristics of the planarized surface of the layer of the wafer meet the planarization objectives and wherein quality of a reflected metrology signal off the target periodic structure meet the optical metrology objectives; and

wherein the one or more underlying structures in the wafer comprises a first layer of underlying periodic structure and a second layer of underlying periodic structure, the periodicity of the first layer of underlying periodic structure and the second layer of underlying periodic structure being positioned perpendicular to the direction of periodicity of the target periodic structure of the wafer.

11. The method of Claim 10 wherein the second layer of underlying periodic structure includes lines and spaces, the spaces being optically transparent to metrology signals.

12. The method of Claim 11 wherein the second layer of the underlying periodic structure comprises lines and spaces and the line-to-space ratio ranges from 0.10 to 0.60.

13. The method of Claim 11 wherein the number of spaces of the second layer of the underlying structure is 2, 4, or 6.

14. The method of Claim 10 wherein the target periodic structure is fabricated using a single damascene lithographic and etch process.

15. The method of Claim 10 wherein the target periodic structure is fabricated using a dual damascene lithographic and etch process.

16. A method of designing underlying structures in a wafer that balances planarization and optical metrology characteristics, the method comprising:

fabricating underlying structures including one or more random shapes and one or more spaces, the one or more random shapes varying in size and/or shape;

comparing planarization characteristics of the underlying layers of the wafer to preset standard planarization characteristics;

fabricating target structures in the target layer of the wafer;

measuring a reflected metrology signal off a calibration test area of the target layer of the wafer to obtain a calibration metrology signal, the calibration test area having an unpatterned underlying structure; and

selecting an underlying structure of the underlying structures of one or more random shapes that yields a reflected metrology signal off the target structure that is closest to the calibration metrology signal, the selected underlying structure having planarized layers that meet the preset standard planarization characteristics.

17. A method of designing underlying structures in a wafer that balances planarization and optical metrology characteristics, the method comprising:

fabricating underlying structures with one or more periodic structures, the one or more periodic structures having one or more lines and one or more spaces in one or more underlying layers of a wafer;

comparing planarization characteristics of one or more planarized layers of the wafer to preset standard planarization characteristics;

fabricating target structures in the target layer of the wafer;

measuring a reflected metrology signal off a calibration test area of the target layer of the wafer to obtain a calibration metrology signal, the calibration test area having an unpatterned underlying structure; and

selecting an underlying structure of the underlying structures with one or more periodic structures that yields a reflected metrology signal off the target structure that is closest to the calibration metrology signal, the selected underlying structure having one or more planarized layers that meet the preset standard planarization characteristics.

18. The method of designing underlying structures of Claim 17 wherein the underlying structures with one or more periodic structures comprise:

a first periodic underlying structure in a first underlying layer with a predetermined line-to-space ratio, the line-to-space ratio being the ratio of area occupied by the lines to the area occupied by the spaces; and

a second periodic underlying structure in a second underlying layer, the second periodic underlying structure having lines covering the spaces of the first periodic underlying structure.

19. The method of designing underlying structures of Claim 18 wherein the number of lines of the first underlying structure is 2, 4, or 6.

20. A method of selecting an underlying structure design that balances planarization and optical metrology objectives for a target structure, the method comprising:

fabricating underlying structures in underlying layers of a wafer, the underlying structures designed to balance planarization and optical metrology objectives;

measuring planarization characteristics of the underlying layers of the wafer;

fabricating a target structure in a target layer of the wafer;

measuring optical metrology characteristics of the target structure; and

comparing the planarization characteristics of the underlying layers to the planarization objectives and the optical metrology characteristics of the target structure to the optical metrology objectives.

21. The underlying structure design optimization method of Claim 20 wherein measuring optical metrology characteristics of the target structure further comprises:

calculating a reflected metrology signal from the target structure assuming the underlying layers are unpatterned;

measuring an actual reflected metrology signal from the target structure; and

comparing the calculated reflected metrology signal to the actual reflected metrology signal from the target structure.

22. The underlying structure design optimization method of Claim 20 wherein the planarization objectives comprise limits on dimensions of dishing and erosion in the underlying planarized layers.

23. The underlying structure design optimization method of Claim 20 wherein the optical metrology objectives comprises meeting a predetermined goodness of fit, the goodness of fit being the inverse of the error metric between the calculated reflected metrology signal to the actual reflected metrology signal from the target structure.

24. The underlying structure design optimization method of Claim 20 wherein the underlying structures in the underlying layers of the wafer include pads, random shapes, or periodic structures.

25. A system for selecting an underlying structure design that balances planarization and optical metrology objectives for a target structure, the system comprising:

a wafer fabricator, for fabricating underlying structures in underlying layers of a wafer, the underlying structures designed to balance planarization and optical metrology objectives, and for fabricating target structures in a target layer of the wafer;

a planarizer for planarizing a surface of one or more layers of the wafer, the planarized surface of the layer of the wafer having planarization characteristics;

a layer profiler for measuring the planarization characteristics of planarized surfaces of the wafer;

an optical metrology device for projecting a signal on the target structure in the target layer of the wafer and for processing the reflected signal from the target structure in the target layer of the wafer; and

a design selector for the selecting the design of an underlying structure that yields a reflected metrology signal off the target structure that is closest to the calibration metrology signal and that meets planarization objectives;

wherein the wafer fabricator fabricating underlying structures in underlying layers of the wafer, the planarizer planarizing the surface of one or more underlying layers of the wafer, the layer profiler measuring the planarization characteristics of planarized surfaces of the wafer, the wafer fabricator fabricating the target structures in the target layer of the wafer, the optical metrology device projecting metrology signals on the target structures in the target layer of the wafer and processing the reflected metrology signals from the target structures, the design selector compares the reflected metrology signal off the target structure to a calibration metrology signal, the calibration metrology signal being the reflected metrology signal off a target structure with an unpatterned underlying layer, and selects a design of the underlying structure that yields a reflected metrology signal that is closest to the calibration metrology signal and where the planarized surfaces of the wafer associated with the selected design of the underlying structure meet the planarization objectives.

26. The system of Claim 25 wherein the underlying structures comprises one or more pads and one or more spaces, the one or more pads varying in size and/or shape.

27. The system of Claim 25 wherein the underlying structures comprises one or more random shapes and one or more spaces, the one or more random shapes varying in size and/or shape.

28. The system of Claim 25 wherein the underlying structures comprises one or more periodic structures, the one or more periodic structures having one more lines and one or more spaces in one or more underlying layers of the wafer.

29. The system of Claim 25 wherein the underlying structures comprise:

a first periodic underlying structure in a first underlying layer with a predetermined line-to-space ratio, the line-to-space ratio being the ratio of area occupied by the lines to the area occupied by the spaces; and

a second periodic underlying structure in a second underlying layer, the second periodic underlying structure having lines covering the spaces of the first periodic underlying structure.

30. The system of Claim 25 wherein the selector is a microcontroller programmed to compare the reflected metrology signal off the target structure to a calibration metrology signal, the calibration metrology signal being the reflected metrology signal off a target structure with an unpatterned underlying layer; to select a design of the underlying structure that yields a reflected metrology signal that is closest to the calibration metrology signal; and to ensure the design of the underlying structure meets preset standard planarization characteristics.

31. A computer-readable storage medium containing computer executable code to select an underlying structure design that balances planarization and optical metrology objectives for a target structure by instructing a computer to operate as follows:

comparing planarization characteristics of underlying layers of the wafer to preset standard planarization characteristics;

measuring a reflected metrology signal off a calibration test area of a target layer of the wafer to obtain a calibration metrology signal, the calibration test area having an unpatterned underlying structure; and

selecting a design of an underlying structure, the underlying structure having a target structure that yields a reflected metrology signal off the target structure closest to the calibration metrology signal and having the planarization characteristics of planarized underlying layers meet the preset standard planarization characteristics.

32. A method of providing a service for selecting the selecting an underlying structure design that balances planarization and optical metrology objectives for a target structure, the method comprising:

contracting by a client and a vendor, for the client to remunerate the vendor for the use of systems, processes, and procedures to select an underlying structure design that balances planarization and optical metrology objectives for a target structure; and

providing by the vendor to the client access to systems, processes, and procedures to compare planarization characteristics of underlying layers of the wafer to preset planarization objectives, to measure a reflected metrology signal off a calibration test area of a target layer of the wafer to obtain a calibration metrology signal, the calibration test area having an unpatterned underlying structure, and to select the design of underlying structure that yields a reflected metrology signal off the target structure that is closest to the calibration metrology signal and where associated planarization characteristics of the underlying layers of the wafer meet the preset planarization objectives.